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A Study on Organizational Design and Operational Planning of Big Data Teams

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Abstract

Previous studies show that the major success factors in the adoption of big data are management support, availablilty of data scientists, and decision-making culture, etc. But, we found the most important factor in successfully adopting big data technology to operations is the creation of a capable big data team. However, simply drawing an organization chart is not enough. Big data operational planning, such as strategy, governance, evaluation, and workforce management are important. As big data team becomes distributed to works closely with business teams, big data analytic results are easily applied to business, and the immediate benefits of big data are realized. Conversely, the more centralized the big data team is, the better utilization of resources and expertise. But it becomes difficult to apply the big data analytic results to business. This study selected 5 Korean global companies for case studies to find design considerations and operation strategies of big data teams.

Keywords: big data teams; big data organization, big data team collaboration; big data analytic topic; big data experts

INTRODUCTION

Previous studies show that the major success factors in the adoption of big data are management support, availability of data scientists, and decision-making culture. Organizational alignment as the most important key factor in the success of big data [1]. Additionally, corporations must also identify business drivers and make decisions based on data. Thus, a professional organization that can identify the needed data, integrate and analyze the data, and perform a series of complex to apply the analytical results. The process of creating a professional organization based on identified business drivers requires the organizational alignment of big data team.

The use of big data requires collecting, processing, analyzing, and utilizing large amounts of data that could not previously be processed in conjunction with substantial professional competencies and close cooperation. Although data scientists provide the core competency of big data analysis, big data engineers are essential for the collection and processing of data. Without the help of business experts who understand the business operations of data, big data be analyzed.

Since open source software is mostly used for big data, the cost of processing big data and the associated general hardware is significantly lower than in the past. As analytic techniques and big data processes such as SQL on Hadoop become similar to relational databases (RDBMS), technologies for processing and analyzing big data are being offered at lower cost than ever. Since general business departments can easily obtain such low cost big data technolgies without help of IT department, there has been a significant impact on the types and operations of big data teams.

Corporations are concerned with the design and operation of big data teams. Unfortunately, few studies explain how big data teams should be adopted, how they should be designed, what types of experts are needed, and how they should be operated.

This study proposes a method to design and operate a big data team. Through an analysis of big data organization types and operational planning, this study examines the operational direction and the roles of the business and IT department and big data teams using cases of global companies that such as Samsung Electronics, Hyundai Motors, Doosan Heavy Industries & Construction, KB Card, and POSCO.

LITERATURE REVIEW

Kates and Galbraith define organization design as the process of aligning organizational structures, processes, rewards, and people to enable business strategy execution [2]. An important purpose of organization design is to allow individuals to demonstrate their enthusiasm for their organizations and to choose the right decisions to execute complex organizational processes. The Star ModelTM was proposed for organization design. Using big data implies internally fast and better decisions, improvements in existing products and services, and enhanced digital capabilities. Additionally, creating a big data team within a corporation creates changes in the existing organization. The first steps in a big data adoption strategy are to nominate a data analysis champion within the executive team, consider data strategic assets of the company, and lead the necessary organizations and activities related to data.

Grossman and Siegel proposed a CSPG framework derived from Galbraith's Star Model for the design of big data teams[3]. CSPG refers to the four elements of big data team

design: culture, staff, process and governance. In other words, the culture for data and analysis should be established, analytical manpower should be secured and educated, the necessary analytic processes should be created, and an optical analytic governance structure should be implemented. There are three types of big data teams according to the set-up of analytic functions within a corporation. The first form concentrates data scientists in one organization as a fully centralized structure. Data and systems are easily integrated with this form because the analytical manpower is centralized. This form is also advantageous for analyzing and predicting data and implementing a data mining model. However, this form is some distance from business departments, and it can be difficult to obtain support from the business departments. Therefore, data scientists may have difficulty understanding and performing the requirements of various operating departments. The second form is a fully distributed structure. This structure disposes data scientists in each business department and obtains better cooperation because the structure analyzes data according to the requirements of each business team. It has a disadvantage in that it cannot concentrate data scientists to solve enterprise problems. The third form is a compromise structure which distributes most data scientists in the central organization and the remainder in business departments. This is also called a big data COE (Center of Excellence).

Pearson and Wegener noted that big data is not a technology but a business program that contains highly technical elements [4]. They divided types of big data teams according to business functions as follows. First, organizations led by business teams analyze big data themselves and make independent decisions. Each organization has different data, and the size of the data is not an issue. AT&T and Zynga belong to this type. Second, some organizations led by business teams have the support of central departments. Each business department makes independent decisions but receives help from the central department regarding specific matters; Google and Progressive are examples of this type. Third, COE (Center of Excellence) organizations lead, cooperate, and guide the big data tasks of each business department. Amazon and LinkedIn are examples of his type. Fourth, there are fully centralized organizations which prioritize, take responsibility, and direct all big data tasks at the center. Netflix belongs to this type.

Chang identified relationship between the new big data teams and existing business teams reflecting Korean corporate culture [5]. Big data teams require at least a data analysis expert that works for the big data team. The data analyst expert produces results from the big data systems. The problem is to create an analytic topic only with analysis experts. Therefore, business teams must provide analytic topics. However, since the business teams have their own tasks, it is not easy for the business and big data teams to collaborate and provide analytic topics. Thus, the position of big data teams changes according to the degree to which the business teams and the big data teams share their roles.

Big data teams are divided into three organizations depending on the degree of connection between business departments and big data teams.

First, as analysis supports organizations, big data teams are organization types that support analysis work according to the analytical needs of the business teams. Such organizations do not make any changes to existing organizations, but business teams request analyses from big data teams. For business teams, this is a convenient organizational type. However, from the standpoint of big data teams, there is a disadvantage in being an analytic team that passively responds to the demands of the business teams. Moreover, decision making that uses data analysis results in business operations that depend entirely on business teams.

Second, big data teams are transferred from business teams. This is a way for each business team to cooperate with big data teams and directors who decide the big data topics and support analyses. While effective in theory, the position of the transferred manager may become ambiguous as to whether they belong to the business team or the big data team. As matrix organizations, they become outstanding if the operations are well managed, but the requirement to report to two managers conflicts with the culture. Thus, some business managers move their affiliation from the business department to the big data team.

Third, big data teams can function as big data centers and as an independent organization. When building a big data center, applications can be received from experts in the business teams who work with analysis experts recruited externally. Occasionally, IT experts are also recruited. The clear goals and business definitions of business teams is an advantage, but there are also many cases where it is difficult to cooperate with business teams because of this reason.

The role of big data teams can be summarized by the analytic topics that are useful to companies' business. The topics create insightful analytic results to drive real value by applying the results to business operations to support business decisions. This requires detailed and multifaceted operational strategies.

McAfee and Brynjolfsson argued that leadership, management of experts, technology, decision making, and corporate culture are important factors in the effective use of big data in management[6]. Galbraith also explained that leadership, organization structure, process, compensation and performance evaluation, and workforce are important factors[7]. Grossman also claimed that process, workforce, and governance are important [3]. McAfee and Brynjolfsson emphasized the following five success factors [6].

Table 1. Five Challenges of corporation that try to adopt big data

	Contents	Activities
Leadership	The success of companies in the big data era is not due to a lot of good data but the setting of clear goals, defining specific details of success, and raising the right questions.	Capturing opportunities Understanding the market Creative thinking Sincere offerings Presenting visions to be achieved
Professional Manpower Management	Data scientists are not easily cultivated. They are difficult to find and manage.	Analyzing semi-structured data and existing structured data Visualization Processing big data Providing for executives after understanding business terms and interpreting problems
Technology	In big data strategies, technology is not a sufficient condition but a necessary condition.	Open source mostly The key is to secure technologies that can be utilized by IT departments Importance of integrating internal and external data
Decision Making	Decisions should be made where information is available. In the big data era, smooth collaboration between organizations is important	Cooperation among those who understand problems in terms of business and those who analyze and utilize data
Corporation Culture	It is not what we think but what we know that matters in data-driven organizations. Decisions should not be made by our sense or instinct.	Decision making based on sincere data Corporation executives should not think of data as a means to support decisions that have already been made

Source: McAfee and Brynjolfsson[6]

Big data teams are mainly characterized by data scientists. However, Chang categorized experts needed for big data teams into four types[5].

The first type of expert is the big data strategist. Big data strategists must understand the strategies of corporations, select the right topics for big data usage, develop utilization plans for the results from business analyses, design processes and action plans, and make evaluations. This role is crucial to the strategic use of big data. Strategists must understand big data analyses, big data technologies, and have domain knowledge and management knowledge. Even if they are essential capabilities for the successful utilization of big data in corporations, few experts have these competencies. A big data champion mentioned by Galbraith is a person with such a capability[8]. The term domain refers to the experience and knowledge of a specific industry or business (personnel, finance, production, distribution, quality, and R&D).

The second type of expert is the big data domain specialist. A big data domain specialist understands business operations and data created in a domain. This expert has deep understanding and industry experience. The expert can explain abnormality in data according to the business situation and interpret the results in the domain environment. This expert can also direct the data analysis.

The third type of expert is the big data analyst. Big data analysts are often referred to as data scientists. These experts model using algorithms such as statistics, data mining, and machine learning and find insights by analyzing data. In addition to statistics, these experts must understand business operations and IT. They are also responsible for providing visual and comprehensible analyzed reports.

The fourth type of expert is the big data IT specialist. Big data IT specialists recognize the data they need according to their business requirements and collect and accumulate data by procuring data from outside. These experts select software and hardware required for the collection, accumulation, and management of data. Big data IT specialists also refer to experts who can design big data systems, model, and build data. These experts must also be familiar with Hadoop/NoSQL and R. These experts should have experience in trouble-shooting when operating Hadoop and Spark and when problems occur in system operations. They should also be able to use Hive or SQL on Hadoop programs that process data according to needed data requirements.

Table 2. Types of big data team (overall)

Type	Grossman & Siegel [3]	Pearson et al.[4]	Chang [5]	Note
Fully Distributed	Fully Distributed	Business Lead		Based on business team. Big data experts belong to business team
Business Support	-	Business Lead and Centralized Support	Business Support	Based on business team. Supported by big data team
Business Transferred	-	-	Business Transferred	Domain experts from business team is transferred to big data team
Big Data Center	Compromised Type	Center of Excellence	Big Data Center	An independent center, but supported by business team
Fully Centralized	Fully Centralized	Centralized	-	Fully independent big data team

All four capabilities can be present in a team of big data experts, and each business department and IT department can share these capabilities. According to the distribution of each competency, the position and role of big data teams will differ.

Park et al. said "There is no guarantee that a big data idea can be used even if it is useful, and the usefulness of an idea is a necessary but not a sufficient condition to increase the utilization of business teams," emphasizing that the leadership of top management is meaningful as the control variable [9]. Big data teams require close collaboration with business teams. Resolving strained relations with business teams is crucial to the success of big data teams, and management leadership plays an important role. Janssen et al. said that decision makers should be able to interpret the results of an analysis and its meaning, and this capability is a factor that can affect the quality of corporate decision making [10].

Grossman and Siegel said it is not easy to analyze big data and derive insights useful for business management and application to business operations. Additionally, a process to use the data should be created and the results monitored [3]. Thus, a big data governance committee, which includes corporate executives, IT representatives, and key corporate personnel, should be established so that analytic topics can be prioritized, resources needed for analysis can be secured, and analytic results that have helped the business can be identified.

RESEARCH METHOD

To analyze the organizational design and operation of big data teams in case studies, this study has constructed five types of big data organization after integrating associated studies. The types of professional organizations are diverse because big data teams vary depending on their relationship with business teams. The following is a summary of big data team types within corporations developed from previous studies.

The fully distributed type has four types of experts in the business department without big data teams. The business support type has only big data analysts, and the business transferred type has only big data analysts and domain specialists. On the other hand, both the big data center type and fully centralized type have all four types of experts. In all cases, big data IT specialists can be employed by big data teams or existing IT organizations. The operation measures of big data teams are composed by integrating the Star Model suggested by Galbraith, CSPG is mentioned by Grossman and Siegel, and five challenging tasks are quoted by McAfee and Brynjolfsson [8,3,6].

Table 3. Operation plans of big data teams (overall)

Integrated Operation Plan	Galbraith Star Model [8]	Grossman & Siegel CSPG [3]	McAfee and Brynjolfsson [6]
Strategy	Strategy	Culture	Leadership, Corporate Culture
Governance	Organization Structure	Governance, Committee	Decision Making
Collaboration Process	Process	Process	Technology
Evaluation and Reward	Reward		
Professional Manpower Management	Staff	Staff	Professional Manpower Management

A big data strategy defines the goal for big data. In other words, the enhancement of products and services to increase the competitiveness of a company is decided through big data analyses, which determine the priority of what occurs in the future. Thus, creating a corporate culture with the necessary leadership is also a component. Governance determines the organizational structure of big data to achieve the strategic goals and to deploy decision-making authority and responsibility for its effective operation. A committee to reflect the needs of the CDO and the results of big data should be considered. The collaboration process focuses on designing and operating a close collaboration process among big data teams, business departments, and IT departments. Particularly, cooperation with business departments focuses on identifying big data topics, applying analytic results to operations work, and cooperating and managing IT departments focusing on building analysis infrastructure. Evaluation and reward requires clear ROI analysis and qualitative analysis for the evaluation of big data teams. Teams also focus on designing and operating the evaluation and reward of business departments performing collaboration at the same time. Professional manpower management includes the recruitment of four types of big data experts from outside and methods to perform big data tasks through internal education and motivation. The case analysis method is conducted with five big data team types and five aspects of big data team operation methods.

Case study has been performed on five companies with extensive interviews of big data executives or team leaders of each company. The news and materials on the companies that had been searched on the internet were used as supplementary purpose.

CASE ANALYSIS

The five companies selected for the case analysis are large global companies that have performed database analyses for a long time. Samsung Electronics, Hyundai Motors, POSCO, and KB Card are organized in the form of a big data center type internally, but they also have elements of the business support type, business transfer type, and the business distributed type. The type of big data team that operates in the field changes dramatically. This study prioritizes the ways in which big data teams cooperate with business teams and how they differ according to the organizational forms.

Samsung Electronics

Samsung Electronics is Korea's largest company and one of the world's largest IT companies. It is the leading global smart phone and semiconductor manufacturer, with sales of 300 million smart phones and a global market share of 20.8% in 2016 [11]. Moreover, the market share of its NAND Flash Memory is 37.1%, twice as large as Toshiba which has the second largest sales. Of course, the amount of data are large, diverse, and exponentially growing on a global scale. Since Samsung Electronics has considered ways to manage data, it is natural to that the company has introduced big data.

Samsung Electronics is divided into three parts: IT and Mobile Communications (IM), which manages the mobile phone business; Device Solutions (DS), which manages semiconductors and LED and Consumer Electronics (CE), which manages home appliances and display. The IM division created a big data center under the Media Solution Center (MSC) in 2014 and was reorganized under the Software Center in 2015. The type of big data team is a big data center, and it also has a business support type in parts. In the DS section, the system engineering team of the business department also provides IT specialists, domain specialists, analysts, and strategists. This case can be considered fully distributed. In 2017, the big data lab of a big data center type was also newly established in the CE sector.

(1) Strategy: The goals of a big data center include product quality improvement, yield improvement, customer analysis and target marketing, search of new product service, and personnel management. Yun, Jin-Soo, the center chief said, "In the future, data will be the basis for all decisions, and big data will be a key result that will affect all areas of production, marketing, and service in the future"[12]. Won-Pyo Hong, president of global marketing, also emphasized the importance of big data, saying "At the launch of Galaxy S6 in April, marketing that targeted 42 million customers in six countries was in progress. This was possible because we identified and segmented the characteristics of customers based on big data analyses. Without big data, Samsung Electronics would have been unable to maintain its current position in the premium phone market"[13]. Moreover, Samsung released S-Detect ultrasonic diagnostic equipment as a result of deep learning analysis based on big data and released the knowledge graph "K#," an open knowledge content map, in 2016. Samsung Electronics won the gold prize in the 2013 Big Data Utilization Analysis Competition for the successful development of the SSD (Solid State Drive) product and its successful launch in 2015 under the active support of its CEO.

(2) Governance: To achieve the above strategic objectives, Samsung established a Big Data Center in 2013 and discovered enterprise-wide tasks. Samsung began the big data pilot project in the fields of user log analysis, web security log analysis, production facility sensing log analysis, social data analysis, G-CIC (Overseas Corporation ERP), performance improvement, and ERP performance improvement. Since then, Samsung electronics has conducted a number of tasks centered on the Big Data Center.

(3) Collaboration Process: A business consultation system between the business and the IM Big Data Center manages inter-departmental transactions for data analysis. In other words, the company is paying for the big data center instead of conducting business data analysis.

(4) Evaluation and Reward: The DS section calculates how much ROI has been realized through the analysis of big data. The IM section assesses how appropriate and effective new launches, customer targeting, and quality analysis were for the products and services using big data.

(5) Professional Manpower Management: The big data team of Samsung Electronics is mainly composed of individuals with master's degrees and doctorate degrees recruited from abroad, and its manpower is excellent. If necessary, the company builds analysis infrastructure and analyzes data with its subsidiary Samsung SDS and a cooperative company for big data.

Hyundai Motors

Hyundai Motors is the world's fifth-largest global automotive company. In addition to data on telematics, production, quality, diagnostics, maintenance, repairs, and customers, big data has been produced in the fields of connected cars that connect cars with roads, cars with cars through wireless communication, and autonomous driving where data have been stored and processed. In the automobile industry, big data has already been introduced and utilized.

Since 2014, Hyundai Motors has established a "Big Data Room," which is a big data team, and operates it through an executive-level director recruited externally. The executive-level director reports directly to the CEO. Big data is in the form of a COE.

Hyundai Motors is in the form of a big data center and is also a business support type. If necessary, the business team also requires the big data center for analysis. Additionally, some business experts have been transferred to the business team, which is also in the form of a business transferred type that derives the big data topic with the experts who have been transferred from the business teams.

(1) Strategy: In 2013, the existing Vehicle Customer Relationship Management (VCRM) team established the process of big data analysis, built big data infrastructure, and systematically managed and analyzed the data produced by vehicles. Later, the VCRM team expanded and reorganized into the Big Data Room to improve existing manufacturing processes, strengthen service capabilities, and create new services. The VCRM team has also collected a large amount of data to develop autonomous vehicles and has studied connected cars by collecting big data based on Hyundai BlueLink, a telematics service. In 2017, the company built a big data center in Guizhou, China to develop connected car technology and has collected and analyzed vehicle information and social data. Vice chairman Chung Eui-sun, directly cooperates with CISCO to develop intelligent vehicles with super-connectivity. Big data is becoming an indispensable tool in the future of Hyundai Motors.

(2) Governance: The executive level supervises the big data center and used to report directly to the CEO. However, it is now under the Telematics Division (R&D).

(3) Collaboration Process: The collaboration between the Big Data Room and the business team is not specified. However, it is considered as the best case of the Fourth Industrial Revolution, which uses IT technology such as big data, artificial intelligence, and the IoT. It has also been awarded the second Korea Big Data Award following Samsung Electronics.

(4) Evaluation Reward: This evaluates how appropriate the results analyzed by the Big Data Room are and whether they have reduced costs. This evaluation does not include the business team.

(5) Professional Manpower Management: There are many experts with a master's degree and a doctorate degree recruited from abroad. Uniquely, the company has also recruited a group of data IT specialists called DevOps. This team builds and manages big data infrastructure and data engineering that extracts and analyzes big data in a usable form. The operation of big data infrastructure is conducted by Hyundai AutoEver, an IT subsidiary. Employees who have transferred to the Big Data Room from the business team are attempting to identify the needs of the business team's big data analysis.

Doosan Heavy Industries & Construction

Doosan Heavy Industries & Construction has built thermal, combined, and nuclear power plants in over 30 countries since 1962. It has provided worldwide customers with accumulated know-how in engineering, procurement, manufacturing, construction, and service. The company opened a remote monitoring service center at the headquarters in Changwon in 2014 and opened a software center in Seoul in 2015. It also created a platform similar to the Predix platform of GE through a benchmarking GE Software Center. Doosan Heavy Industries & Construction is starting a new business by providing big data-based engineering services to its customers.

The Company has different approach to big data organization. It supports external big data services as separate business group (fully centralized) as well as supports internal big data services for other business departments (data center).

(1) Strategy: The Company has consolidated the work of six affiliates by benchmarking the GE Software Center and creating a platform similar to GE's big data platform, Predix. The company also created the Data Innovation Center (DIC), a big data team composed of business manpower through which it began external services. This required the development of big data service software and data analysis for external services; therefore, big data IT specialists are also present. In 2017, a new Service

Business Group, was established as an independent business department that improves the performance, organizes, and maintains products and receives service commissions after selling power plants or engines.

(2) Governance: Since it is an independent business division, DI organization has complete authority. It is a fully centralized-type center that solves everything independently with the active support of the CEO and strong leadership.

(3) Collaboration Process: Domain specialists from the business team allow the DIC to manage almost everything.

(4) Evaluation and Reward: Each Big Data Analytic project is evaluated by Return On Investment, but there is no individual reward as a return.

(5) Professional Manpower Management: Manpower was transferred internally, and big data experts were recruited externally.

KB Card

The card industry is actively engaged in big data services and big data consulting activities for government agencies and corporations using big data to recover profitability as the commission rate is lowered. KB Card has developed a variety of services and products by expanding its long-running CRM system based on big data. The company is operated directly under the CEO and has a big data strategy center. It is a type of big data center, and topics are derived from the business team, which is supported by the big data center. The organization consists of a data planning team, a data analysis team, and a data marketing team.

(1) Strategy: The company had experience building and operating a CRM system since the early 2000s and was the first to introduce big data in the card industry. Since 2016, its data strategy department has been expanded and reorganized for the big data strategy center. The company is now expanding into various external businesses. The CEO emphasized big data management and noted that the future depends on data. In the existing commission-based card business, its profitability has been enhanced through the big data-based external service business. Particularly, the big data offering system was built through artificial intelligence and voice- based analysis. After analyzing consumer patterns, a real-time marketing technique was developed. The company has formed a big data partnership with NICE Zini Data and founded a service business for big data utilization.

(2) Governance: The IT division of KB Card knows the card business; thus, the IT division develops insights on big data and delivers them to the business department. As the big data strategy center was promoted under the direct control of the CEO, the center chief was also promoted to managing director from department head. The big data center is responsible for the utilization of big data and internal diffusion, and the IT department is in charge of analyzing infrastructure operations.

(3) Collaboration Process: There is effective collaboration among departments. The basic topic of discovery is carried out by the data planning team of the big data strategy center, and there is a business support system for the business team A recently built analysis platform reflects the demands of business operations. In the future, this analysis platform will be used to explore analytic topics in collaboration with the business team. The collaborative system is becoming more formalized with the support of a powerful CEO and big data center chief.

(4) Evaluation and Reward: Currently, a Leave Prevention Model, Overdue Model, Card Loan Model, and Customer Complaint Model are implemented. ROI is predicted by a field test for each model or operation. For the Customer Complaint Model, submitting a complaint to the Financial Supervisory Service can damage the company, and preventing a single complaint is effective. The company has evaluated its model through a comparison with existing models and has verified the effectiveness of new models such as the Civil Complaint Model.

(5) Professional Manpower Management: The company recruits outside talent on a small scale, and most employees are developed internally including big data IT specialists in analysis, domain, and strategy. The company also collaborates with external professional companies to conduct the customer Voice of Customer integration project.

POSCO

The steel industry is sensitive to economic conditions and requires large-scale investment. Maintaining product quality is the key to corporate competitiveness. Therefore, POSCO has made enterprise-wide efforts to optimize data analysis processes after Six Sigma initiative in the early 2000's. In 2013, the company adopted big data with 20 subjects as a pilot program. Since 2015, the company has implemented a data-based smart factory through the IoT. Smart factory is equipped with sensors for steelworks processes and diagnoses the status of manufacturing facilities in real time. The company also analyzes the collected data to identify the facilities that might have potential problems to maintain a stable operating environment and extend the lifespan of facilities.

In 2013, a taskforce team called the "big data study group" was formed under the CIO and promoted 20 big data pilot projects. A big data team was created with a center type.

(1) Strategy: The company's goal through big data is to establish a smart factory and, recently, to create an intelligent factory by introducing artificial intelligence. The areas where big data is applied are broad including the fields of general

management, information security, and manufacturing such as quality management, quality prediction, and predictive maintenance.

(2) Governance: The current big data team is under a CIO, and the CIO also plays the role of CDO. This was possible because the CIO led the enterprise-wide process innovation project that has been ongoing since the late 1990s.

(3) Collaboration Process: Mostly the business team discovers tasks, but the top-down method is also used because it is required from the top. Sometimes, the big data team also discovers its own tasks. In case of tasks that were discovered in various ways, the big data team operates independently and sometimes operates with external expert teams. Analyses results are easily applied in practice since the business teams of POSCO have previous experiences with the Six Sigma method.

(4) Evaluation and Reward: When performing a task, the big data team prepares an execution plan, and the team always details the assignment evaluation method. ROI is calculated quantitatively. The CEO is fully supportive of the big data team, and the team evaluation is positive since the performance that it has created can be proven objectively.

(5) Professional Manpower Management: POSCO has all four professional manpower types of big data. Big data strategist, domain exerts, IT experts, and analysts are transferred and work together in a subsidiary IT field called POSCO ICT. They have become the main body and lead topic discovery related to big data.

Result of Overall Analysis

Table 4 summarizes the five cases. Organization types fit into the five categories with flavor of other organization types for inter-departmental cooperation. The business division of Samsung Electronics is bigger than that of the large corporations. Three business divisions of Samsung each have a different big data team. Samsung Electronics, Hyundai Motors and KB Card belong to the big data center type, but they also play the role of business support type that supports business team demand for analysis. Doosan Heavy Industry provides not only external big data service to their customers but also supports internal business departments by big data center. The CEOs of the companies actively support the use of big data. However, the CEO support did not replace the cooperation with business departments. Excellent professional manpower in big data teams was not significant to the success of big data team.

Table 4. Case Summary

		Samsung Electronics	**Hyundai Motors**	**Doosan Heavy Industries & Construction**	**KB Card**	**POSCO**
Type of Organization		Big Data Center, Business Support, Fully Distributed Coexist (These three types are separately operated)	Big Data Center, Business Support, and partly Business Transferred	Fully Centralized and Big Data Center	Big Data Center and Business Support	Big Data Center
Integrated Operation Plan	Strategy	Clear goals and active support by CEO	Expanded existing VCRM. Extended big data of analysis experience. CEO support	Independent Department. Foreign Service. Support of CEO	Expansion and Reorganization of CRM team with existing analysis experience	Smart Factory. Support of CEO
	Governance	Big data team for each division	Under Telematics department which collects the data most easily	Independent Organization	Originally under IT organization and recently became independent.	Under IT organization
	Collaboration Process	Transactions among internal divisions	Request of business team and analytic topic discovery of the center	Business team discovers its own topics	Topic discovery through business support	Abundant analysis experience through Six Sigma activities. Topic discovery through diverse ways.
	Evaluation and	Innovation support of	Originality and	Effectiveness of	Result of foreign	Independent ROI

Reward	ROI and product/service	application effect of analytic results	foreign service	service	analysis
Professional Manpower Management	Recruited experts with master's degree or doctorate degree	Internal transfer and the level of masters and doctors from overseas	Internal transfer and IT personnel. Recruitment of external analysis experts	Independent development without external help (outsourcing), independent operation. Accumulation of internal big data experience	Cultivating experts through internal education. Manpower procurement through a subsidiary POSCO ICT.

CONCLUSION

All five companies accumulated analysis capabilities in business operations prior to the introduction of big data. DS of Samsung Electronics implemented the analysis of semiconductor yield, Hyundai Motors implemented VCRM, KB Card implemented customer analysis by adopting CRM, and POSCO implemented Six Sigma activity in early 2000's. Since such analysis capabilities were accumulated, big data were implemented enterprise-wide without much difficulty. Therefore, the accumulated data analysis capability of business departments significantly influences the successful adoption of big data.

Big data functions vary greatly depending on which department the big data experts belong to. If the experts were under the CEO, CIO or R&D, they had more freedom to function since these departments were not revenue-generating departments but were supporting divisions. However, if the experts were part of business organizations, the big data teams also had to generate revenue, provide analysis between departments and settle the cost internally. In this case, business departments may avoid the analysis services of big data teams.

The advantages and disadvantages of big data team types can be summarized as follows. Each company and division selects the type of big data that fits reality, but a setup that can prevent the redundancy of manpower, data, and infrastructures if it becomes a distributed type is required. If an organization is close to the centralized type, an institutional setup or collaboration process should be stipulated to facilitate communications with the business team and bring it closer to the field. The following is a list of the advantages and disadvantages of each type of big data team and the necessary actions that should be taken to overcome the disadvantages.

Table 5. Advantages and disadvantages of types of big data team

Type	Advantage	Disadvantage	Corresponding Behaviors
Distributed Organization	Field-friendly analysis Easy to apply analytic results Easy to achieve visible effects of big data	Manpower, data, and infrastructure are distributed Accuracy problem due to data distribution Vulnerable to enterprise-wide analysis	Necessary to rationalize the cost as a result of ROI applied to analytic results Support measures should be taken if enterprise-wide support is needed
Centralized Organization	Prevention of redundant investment Easy to secure information and integrate data Generation of synergy among professional manpower	Analytic results are far from field Difficult to apply analytic results to the field Difficult to discover big data topics.	Maintain close cooperation with business teams Needs service minds for business teams Actual cases of business application should be discovered and reported to business teams

Big data teams can be praised by the CEO if they report directly to the CEO, but related business departments were sometimes criticized by the CEO. As a result, business departments were unable to collaborate with big data teams. In such cases, big data team support of business departments reporting to an executive committee is a way to strengthen their collaboration in the future. The analytic results of big data can be applied to business operations, and the performance can be seen if the evaluation of the performance between business divisions and big data teams are concurrent, but insights may not be applied to actual business operations if the evaluation of business divisions and big data teams occurs separately.

If there are big data teams within an organization, employees in the business department may often question the value of the big data team. Thus, it is important for big data teams to perform ROI analysis for each big data analysis task because the ROI analysis proves the value of the big data teams. The purpose of big data teams is to discover big data topics useful for business, analyze data, drive insights, and apply them to actual business operations to strengthen the companies' competitiveness and differentiation strategies. Therefore, the evaluation of big data teams should be part of the whole process. Cooperation between business teams and IT departments should discover and quantitatively assess KPIs that enable collaboration among big data teams, business teams, and IT departments, and a device should be provided to qualitatively assess them in high-level organizations. Discovering big data topics is difficult and important. In the case of POSCO, business analysts who knew the business operations played an important role in finding big data topics and utilizing analytic results. Experienced retiring experts who had substantial experience remained as business analysts to retain their capabilities.

As big data technology has become popular and the cost of introducing big data has reduced, business departments often introduce big data directly without going through IT departments or enterprise-wide coordination. This is a fully distributed type of business department rather than a big data team. The advantage is that the business department can immediately apply the analytic results of big data to business operations without having to adjust the central big data team, achieving an immediate effect. Additionally, no changes to the existing organization are required, and there is minimal organizational resistance. Of course, there are also tendencies to operate big data in a silo-type model. However, where business operation is independent such as the manufacture of semiconductors, it should be applied immediately for results rather than coordinating enterprise-wide opinion. Such tendencies were evident in big data teams. In many cases, instead of entrusting existing computing departments to build and use big data infrastructures, big data teams recruited IT specialists and built big data infrastructure directly. The accumulation and utilization of big data inevitably led to conflicts with existing IT departments. To avoid this, big data teams used the System Integration organizations of their affiliates or introduced a reviewing cloud for big data. Data ownership implies that departments that create data for each business department have ownership of data and, for other departments to share the data, having to ask permission from the department with ownership is problematic. All companies deal with this matter differently, but typically they do not share sensitive data such as quality or R&D data. Analyses that affect quality in modern processes are almost impossible except for the department in charge. This type of data ownership is considered a serious issue. Compared to organizations without a CDO, big data teams with a CDO easily solved silo operation problems among organizations, collaborative process issues among departments, data ownership issues, CEO report issues, and performance evaluation issues. The CDO system proved to be very effective in the success of big data.

Big data teams differ according to the size of the company, industry, or the leadership of the management team, but there is a limit to the number of companies used as cases, and it was difficult for them to reveal all the aspects of the big data teams. These were the limitations of this study. The plan for research is to study the organizational design and operation strategies for utilizing and establishing the relationship between the digital transformations of enterprises and the digital capacity of companies that have a fundamental impact on the Fourth Industrial Revolution.

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